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TREATMENT OF FEVER.

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WATER IN THE TREATMENT OF FEVER.

Anatomy.—The skin has, in man, a superficies of about fifteen square feet. It is composed of three coats: an outer, called the cuticle, or *epidermis*, of a horny nature; a middle, of a soft pulpy consistence called *rete mucosum*, or mucous body; and an inner, of a dense resisting character called the true skin or *chorion*.

On the upper surface of the true skin are distributed, in great profusion, nerves and small vessels; some of these vessels convey blood; others, lymph; surrounding and penetrating the coats of these vessels to their most minute distribution are the automatic nervous branches. This is the nerve of the blood, absorbent, and secretory vessels; and wherever they ramify they carry along with them minute branches of this nervous system. It creates, maintains, and governs the functions of these vessels.

The cuticle has no sensibility, and is, therefore, wonderfully adapted to the protection of the nerves, glands, and vessels of the other coats. It has openings, or pores, which admit the escape of perspirable matter and certain gases secreted by the glands under the mucus coat and upon the true skin. These openings are not direct communications; they go some way obliquely under the cuticle before they open externally. On the upper surface of the true skin and immediately under the mucous coat are a countless number of glands of secretion and of absorption. Some of these glands display functions nearly identical with those of the lungs in respiration. They secrete the same gases and absorb the same gas as the lungs.

The community of function between some of the glands of the skin and those of the lungs is so nearly identical, that, in some animals, as the common leech, both are performed by the skin; and in others, as the frog, which will survive longer the excision of the lungs than the loss of the skin.

The skin has a continuity of structure with the lining membrane of the respiratory, the digestive, the urinary, and the uterine passages. This is the physiological reason why the states of the skin both modify and are modified by the functions of respiration, digestion, and urination. The mucous coat of the skin, in some degree, protects the vessels, nerves, and glands from compression and contusion. While the cuticle is hard and the true skin firm, this is soft and yielding. The cutaneous glands have a perfect glandular organ-

ization. The arterial, venous, lymphatic, and capillary vessels, and the automatic nervous branches, minutely ramify through its structure.

Physiology.—Blood, rich in nutritive and effete elements, is conveyed along the arteries to the capillaries in which it undergoes a series of cellular changes, by which the nutritive are separated from the effete. Each class of these elements undergoes further molecular changes by which the former is prepared and appropriated to the nutrition of the different external tissues; while the latter is elaborated and coalesced into various secretory elements, and removed from the cutaneous tissues in the form of compounds, as sweat, carbonic acid gas, &c. These molecular mutations are accelerated by the absorption of oxygen from the atmosphere by certain cutaneous glands in a mode nearly identical with that in which the lungs absorb atmospheric oxygen; and oxygen in the external capillaries combines with the carbon of the food, evolves heat, and is removed by secretory action in the form of carbonic gas. When these elements are combined in the lungs heat is evolved, and carbonic gas formed and secreted.

Are not the functions of the lungs and those of the skin, in this particular, identical? They certainly produce the same results.

When the blood arrives in the external capillaries its elementary composition is not the same as when it was returned from the lungs into the left side of the heart, because it is a living and growing fluid. From the time the organizing force of the automatic nervous branches at the mouths of the absorbent vessels begins to act on the organizable elements of the food and drink until the blood is conveyed to the tissues it is designed to nourish, it is in a state of constant growth, when it attains maturity and is appropriated. Every tissue of the organism is nourished by its own capillary vessels designed for that particular purpose. The living circulating mass supplies the material out of which the automatic nervous force of these vessels elaborates and appropriates the nourishment of the tissues. When the blood is normal the different forms of the automatic nervous force readily obtain a supply of nutrient material; and all the functions of the organism are performed with comfort and regularity.

Not only the blood has a period of incipiency, growth, and maturity, but so, also, has each cell of which it is composed. For practical purposes, the cells of the blood may be arranged into two classes: one, to nourish and build up; the other, to tear down and remove. When the human organism arrives at maturity they should be exactly equal to each other. From this physiological fact it is evident that a normal quantity of blood must be conveyed into the external capillaries, in which it must undergo normal molecular changes in order to maintain the external tissues in a healthy condition.

Pathology.—If, from any cause, the blood is not conveyed to these vessels in normal quantity and quality, the temperature of the skin will be abnormal. This is fully evinced in every state of fever, from its incipiency to its termination. I have endeavored to show that the automatic nervous system creates,

maintains, and governs the circulation of the blood, and produces all the molecular changes which occur in the capillaries (*Amer. Med. Journ.*, July, 1855); and that, therefore, the primary link in the series of functional lesions which produce *fever* must be a lesion of this force in these vessels (*Amer. Med. Journ.*, April, 1856).

From the physical position and anatomical structure of the arterial, capillary, and venous systems of the skin, and from their physiological relation of function to that of these systems in the other great depuratory glands, the liver, the kidneys, and the lungs, it is evident that the primary impression of the electrical disturbance in the atmosphere, the disturbing force of which produces a lesion of the automatic nervous force, must first take place in these vessels.

The degree of lesion between the elements of the blood in the external capillaries depends on that of the electrical disturbance, and that of the resistance to the force of this disturbing cause offered by the organism. It may be slight, when it will soon be removed by the superior force of the different forms of the normal automatic nervous force in these vessels. But each time this lesion is produced by an electrical disturbance in the atmosphere, the less the degree of resistance offered by the organism; so that by the frequent repetition of the electrical disturbance, although it may not be, at any time, increased in intensity, a diseased state of all the elements of the blood will be gradually produced. This is fully evinced by the ordinary symptoms of fever.

The disturbing force of electricity may be of sufficient intensity and duration to produce a diseased transformation of all the tissues in a few hours. Then the most malignant symptoms of fever are manifested. When fever is produced in the former mode, by the gradual disturbance of the normal relation between the elements of the blood, the skin is either hot and dry, or cool and bathed in perspiration.

During the progress of fever the skin often communicates the sensation of increased heat, when its temperature, as indicated by the thermometer, is not augmented, because the skin, when dry, is a better conductor than when moist, and because no increments of heat are lost by transmutation into mechanical force by which sweat is driven from the surface. The sufferer often imagines he is almost burning up, when the temperature of the skin evinces no increase of heat. Why is this?

The pathology of the blood reveals the answer. All of its elements are in a state of diseased transformation. The different forms of the automatic nervous force normally manifested as nutritive attraction by which the tissues are nourished, and effete repulsion, by which they are freed of effete elements, are, in some degree, changed into abnormal or chemical force. Hence the elements of the blood are abnormally transformed; they do not nourish the tissues, but they are the agents used by the chemical force to facilitate the molecular decomposition of the solid tissues. The organizing force of the digestive organs no longer attracts the organizable elements of the food. New

material for normal blood is not absorbed and elaborated. The growth of the blood is soon arrested when the superior quantity of the augmented chemical force transmutes its elements abnormally and produces their re-arrangement in accordance with chemical laws.

When the elements of the blood are abnormally transformed, the albuminous undergo imperfect molecular development. The organizing force of these elements attracts the oxygen of the atmosphere imperfectly, because of their deficient molecular arrangement in the pulmonic and cutaneous capillaries. A limited quantity only is absorbed. This oxygen is an important nutritive constituent of the albuminous compounds. They cannot attain perfect molecular growth without its elementary combination with the other elements of the protein compounds. When, from any cause, this combination is imperfect, the molecular development of the protein compounds must therefore partake of this imperfection. The automatic nervous force, which is manifested between the elements of these compounds in the form of nutritive attraction, is increased in some capillaries, decreased in others, and perverted in all.

When the organizing force of the protein elements is in this manner disturbed, they may attract the oxygen of the atmosphere, and cause its absorption, either by the pulmonic or cutaneous capillaries; but, when absorbed, it cannot undergo normal cellular development and combination with the other elements of the protein compounds, because of the lesion of the organizing or nutritive force. Its presence sometimes gives perverted motion, but always diminished power, to the organizing force. Hence the manifestations of this force is then irregular and imperfect. Neither the nutritive nor the effete elements undergo normal mutations. Secretion is increased in the capillaries of some of the glands, decreased in those of others, and perverted in all.

Animal heat is produced by the normal molecular changes the elements of the blood undergo in the capillaries of the organism. It is generated as much by the food we eat and the fluids we drink, as by the oxygen we inspire. It is not developed by a simple chemical combination of the carbon of the food and of the oxygen of the atmosphere. To generate and develop animal heat is one of the series of the processes of nutrition; unless all these processes are normal, the quantity of heat cannot therefore be normal.

When lesion of nutrition and secretion exists in all the tissues, the cellular changes of the nutritive and effete elements are not performed with normal regularity and in normal quantity; because the oxygen of the atmosphere, absorbed by the glands in the pulmonic and cutaneous capillaries, is acted upon by the organizing force in some of the capillaries only; while, in others, it is not consumed by molecular combination, but remains, in a great degree, free to combine, not only with the abnormal elements of the blood, but also with the protein elements of the solid tissues. The consuming force of the free oxygen, acting upon the organizing force of the solid tissues, produces in those tissues, to which branches of the sensitive nervous system are distri-

but, the sensation of *heat*, or *burning* and *pain*; in those to which excitatory branches are distributed it causes *irregular* and *involuntary* muscular action; and in the blood, which has no other nervous endowment except that of the automatic, it augments the lesion between the elements of the blood, produces the sensation of *thirst*, facilitates the formation of congestion and inflammation, and accelerates the molecular changes of the different forms of the automatic nervous force into that of the chemical.

When the different forms of the chemical force, which is an abnormal manifestation of the automatic, are extended to the sensitive and excitatory tissues, a *shivering* or *chill* is developed; manifestations of augmented and perverted sensation and irregular and involuntary muscular motions transpire; a lesion of circulation in the external capillaries exists; the blood is neither normally attracted nor normally received in these vessels; the muscular action of the heart and arteries becomes tumultuous; an abnormal quantity of blood accumulates in the thoracic and abdominal venous systems.

The molecular changes of the normal automatic nervous force of the external capillaries consumes by cellular combination the excess of the chemical force between the elements of the diminished quantity of blood remaining in these vessels; the sensation of warmth is restored; muscular action is tranquillized; the blood, greatly contaminated by the retained effete elements of the food and of the transformed tissues, begins to return in increased quantity to the external capillaries, whose normal organizing force consumes, in some degree, the different forms of the chemical force between the elementary constituents of the blood; removes a quantity of the effete elements by secretion, and conveys the blood, thus partially depurated, into the venous branches, by which it is returned to the heart. The mechanical force of the muscular action of the heart propels the blood into the arteries, in which it undergoes a continued series of molecular changes till it is conveyed into the capillaries, in which a different and an augmented cellular mutation transpires, a quantity of effete elements are removed by secretion, and the blood again conducted into the venous branches.

When the organizing force of the automatic nervous system is superior in intensity to that of the different forms of the chemical, each time the blood is conveyed through any of the great depurating glandular systems a quantity of its effete elements are removed by secretion; but when the organizing force is inferior in intensity to that of the chemical, the blood becomes more and more contaminated by the effete elements of the transformed tissues of the organism, until the organizing force is consumed by the molecular changes of the multiplied forms of the chemical, and life is extinguished.

The depuratory glands maintain a complementary relation of function with each other; and it seldom occurs that the functions of all are alike diseased. When the lungs, the liver, or the kidneys are congested, the skin is always anaemic; when inflammation, which is excessive and perverted nutrition, exists in any of these glands, the external tissues are always more or less

bloodless, according to the duration and degree of that diseased condition and the causes by which it is produced; and when the external capillaries are congested, or when they are the seat of excessive and perverted nutrition, the circulation in the other depuratory glands, especially the liver and the kidneys, are proportionally disturbed. From the anatomical structure of the portal venous system, the capillaries of the liver and the kidneys are more liable to congestion than those of the lungs, when a recession of blood takes place from the external capillaries; because the veins in this system, like those in the lungs, are without valves, but of larger size, and in a position more favourable for the reception and lodgement of blood by its retrograde movement from the right side of the heart. When lesion of circulation exists in the external capillaries, a reflux of blood into the portal system always occurs in a proportion of direct equivalence to the degree of this lesion.

Either a determination of blood or a congestion in the hepatic, the renal, or the intestinal capillaries, may be produced according to the duration, repetition and intensity of the disturbing cause and the degree of resistance offered by the organism.

When the blood is determined to the liver by recession from the external capillaries, retaining effete elements which should have been removed by the depuratory glands of the skin, the presence of an increased quantity of abnormal blood in the hepatic capillaries is always evinced by the secretion of an augmented quantity of *bile*, which is often perverted in quality.

Congestion of the liver exists, when the molecular changes of the blood in the hepatic capillaries is, in a great degree, controlled by the superior intensity of the chemical force. The secretion of bile is then always greatly decreased, until the automatic nervous force of the capillaries is almost wholly transmuted into chemical, when the biliary secretion is largely augmented in quantity, but altered and perverted in quality. These conditions of the biliary secretion have often been observed in this climate, when the days are hot and the nights cool, in alluvion districts abounding in stagnant water; and in a more southern climate, when the dew-point is high, a perverted state of the biliary compound is always present during fever.

Lesion of the external capillary circulation must always take place *before* a determination of blood to the liver and kidneys, or a congestion in these glands, can occur. The blood must recede from the external capillaries into the portal system, and its retention there must be favoured by the imperfect introduction of the blood from the arterial branches into these vessels; because, when the blood is normally admitted into them, the equilibrium of the circulation is soon restored, and the abnormal accumulation of the blood in the portal system ceases to exist.

A *bilious* derangement cannot, therefore, be produced without a *previous* lesion of the circulation in the external capillaries. All the tissues are formed by the organizing force of the automatic nervous system out of the organizable material of the maternal blood during embryotic life; and, after birth, they

are nourished and sustained, decomposed and removed by the varied and different forms of this force. Cells are the agents which it employs to perform all its functions in the organism. Throughout every tissue they obey the mandates of this force. Hence what they do, whether normal or abnormal, indicates the *state* of this force in its multiplied forms. Their physiological productions and pathological manifestations should, therefore, be attentively observed and assiduously studied.

When the organizing force is diminished in quantity and weakened in intensity in the external capillaries by a recession of blood from these vessels to the venous system of the thorax and abdomen, caused by electrical disturbance in the atmosphere, and by the retention of the effete elements of the food and of the transformed tissues, it is of the first importance to determine, with some degree of confidence and certainty, the compensatory assistance which its vast multiplicity of forms in other tissues will lend to restore it to a normal condition in these vessels. They are all endowments of the organism; all they do is for its conservation; but what can they do now?

The blood is diseased by a lesion of the organizing force between its elements; many of its cells neither grow nor mature; they contain organizable constituents; these are not organized normally by normal forms of the organizing force; but abnormally, by perverted forms of this force; they aggregate and constitute either congestion or inflammation, or both, in the great depuratory glands. There is a lesion of nutrition; the supply of nutritive material is proportionally diminished; only a small number of new recruits are mustered into the service of the organism; these have not been trained to obey the commands of the organizing force; they too often desert and seek association among the tumultuous host governed by chemical force. There is not a sufficient quantity of normal cells which undergo normal molecular changes to maintain a perfect equilibrium between the processes of waste and repair. Their quantity must be increased. How can this be done? Not by the introduction of nutritive elements; but by the depuration of those which already exist among the other elements of the blood. This can only be accomplished by molecular changes of these elements, by which the effete are elaborated and separated from the nutritive.

The diminished quantity of the organizing force in the external capillaries, caused by recession of blood from these vessels into the portal venous system chiefly, the superior intensity of the chemical force in the blood, thus accumulated in this system in augmented quantity but perverted quality, and the consuming force of the imperfectly combined oxygen of the atmosphere, introduced into the blood at each inspiration, resist the fulfilment of this restorative indication. The imperfectly combined oxygen is not only consuming, by molecular combination, the nutritive elements of the blood, but also the solid tissues.

A complete lesion of nutrition is soon produced; the chemical force, in its multiplied forms, rapidly augments in intensity by superior quantity; the

sensations of *thirst* and of *increased heat* are urgent and agonizing; *pain* is felt; oxygen is consuming the sensitive nervous branches.

The *first* indication to be fulfilled is the *removal* of this *oxygen*. This must be done by molecular combination.

As vacuity always favours absorption and repletion retards it; and as the external capillaries are comparatively in the former condition, while the hepatic and renal capillaries are strictly in the latter, it follows that absorption would take place with much more celerity in the former. When this abnormal state of the circulation is associated with the physiological fact, that the different forms of the automatic nervous force maintain and control the elements of the blood in the external capillaries, while pathology as plainly indicates that those of the chemical predominate more or less over these elements in the visceral capillaries, a comprehensive appreciation of the varied functions of the organism and of the compensatory assistance they afford each other, most conclusively show, that curative means should be addressed to the external capillaries commensurate with their depurative and compensatory functions.

This proposition is supported by the anatomy and physiology of the cutaneous tissues as well as their physiological relation of function and pathological compensatory assistance. We have abundant evidence that the sensitive and excito-motory nervous branches are largely distributed to the tissues, through which the external capillaries are ramified, by which these nervous branches are supplied with nourishment, and receive the disturbing impression of the chemical force; that the tissues to which the visceral capillaries are distributed have no sensitive and excito-motory endowments; that the sensitive nervous system is the agent the automatic employs to bring the organism into relation with the external world; that the excito-motory is the agent it uses to protect the organism from external objects; and that these two nervous systems often lend a compensatory aid to the automatic. Their restoration and conservation should, therefore, always be a primary object.

The existence of imperfectly combined oxygen in the external capillaries will, for this physiological reason, be instantly evinced by the sensation of pain and increased heat of the skin and the manifestation of involuntary muscular motions, while a proportionate quantity of uncombined oxygen in the visceral capillaries, which have not these nervous endowments, would only excite the sensation of *thirst* and *oppression*. The imperfectly combined oxygen should, therefore, be consumed by molecular combination in the external capillaries and be removed by secretion, so that the sensitive and excito-motory systems would be in a condition to lend compensatory assistance to the automatic in the depuration of the blood in the other depuratory glands. How can the removal of the imperfectly combined oxygen of the atmosphere in the external capillaries be accomplished? By the *use of water*. Its temperature and its mode of application must be governed by the state of the different forms of the automatic nervous force. This is indicated by the augmented or diminished quantity of blood in the external capillaries; by the tempera-

ture of the skin; by the mechanical force of the muscular action of the heart and arteries; by the state of the venous system, whether congestion exists in any of the great depuratory glands or not; by the decreased and perverted, or the increased and perverted, sensibility of the sensitive nervous system; by the irregular and involuntary muscular motions of the excito-motory system; by the lesion of the nutritive process; and by that of those of secretion.

When warm water is properly applied to the cool skin, a certain quantity of its heat is instantly transmuted into animal electricity. This gives increased intensity to all the forms of the automatic nervous force; the molecular changes of the blood are augmented and accelerated; water is absorbed; the imperfectly combined oxygen in the blood attracts the hydrogen of the water, combines with it, and is secreted in the form of sweat; the oxygen of the water combines with the carbon of the blood, evolves heat, and is secreted in the form of carbonic acid gas. A comfortably soothing sensation reigns supremely through the tissues endowed with sensitive nervous branches. The external capillary circulation is greatly augmented and accelerated; an increased quantity of arterial blood is attracted and introduced into these vessels by the superior intensity of the molecular changes of its elements; the mechanical force of the muscular action of the heart and arteries is stronger and more tranquil; respiration is freer and less hurried; copious sweating ensues; and a large quantity of effete elements are depurated from the blood.

When the skin is hot and dry the water used should be cool. Why? Because there is an abnormal quantity of animal heat and electricity retained in the external capillaries by deficient secretion.

The low temperature of the water increases its capacity for animal heat and electricity, and promotes the affinity of its elements for each other. When it is applied and retained upon the skin, it attracts animal heat and electricity, and causes the secretion of an increased quantity by the cutaneous glands. When the aggregated heat and electricity are thus removed, the different forms of the organizing force assume increased activity; water is absorbed and decomposed; the molecular changes, which then ensue, are the same as those that transpire when warm water is employed.

Sweating may and often does transpire freely without any considerable diminution of the temperature of the skin; because it is only one of the processes of the secretion which takes place in the cutaneous glands. In this state of the skin, the indications for the employment of cool water are nearly the same as when it is hot and dry.

While portal congestion exists, neither the external nor the internal use of water is adequate to the restoration of the functions of the glands, to which this venous system is tributary; because the hepatic, renal, and intestinal capillaries are replete to distension; and only a small portion of this blood passes into the pulmonary circulation in consequence of its retrograde motion from the right side of the heart, or of the enfeebled mechanical force of the muscular action of this organ. The almost complete transmutation of the dif-

ferent forms of the automatic nervous force into those of chemical, by the superior intensity of the augmented quantity of which the molecular changes of the blood in these vessels are governed, causes the absorption and secretion of the hepatic, renal, and intestinal glands to be either greatly decreased in quantity and vastly altered in quality, or largely augmented in amount and wonderfully perverted in elementary arrangement and chemical composition. If, therefore, water be introduced, either by drinking or by injection, into the alimentary canal, it cannot be normally absorbed, nor can it undergo normal molecular changes, because chemical force prevails over the cellular changes which transpire between the elements of the blood and the solid tissues. Water cannot then be normally absorbed, and, if it be abnormally taken into the circulation, it cannot undergo normal molecular changes, constitute an elementary constituent of the blood, and promote secretion; because both absorption and secretion are produced by the cellular formation and coalescence of the elements of the blood; and they always bear a relation of direct equivalence to the increase, decrease, or perversion of these molecular changes.

I have shown that the hepatic, renal, and intestinal capillaries are more or less replete according to the degree of portal congestion; that repletion retards absorption; that the different forms of the chemical force predominate over those of the automatic, when this congestion exists; and that this predominance always decreases and alters, or augments and perverts absorption and secretion in a proportion of equivalence to its degree of prevalence. Hence it is an obvious fallacy to endeavour to restore the normal secretory action of the hepatic, renal, and intestinal glands by the introduction of large quantities of water into the alimentary canal. It is not only erroneous, but often positively injurious, because the mechanical force of distension by an elastic substance like water always favours absorption, while it proportionately retards secretion. The capillaries of these glands are already too much distended by the aggregated blood; why increase their distension by the introduction of water? The blood is so altered in quality, and so perverted in elementary arrangement and chemical composition, that it cannot undergo normal molecular changes. Will not the additional water introduced by abnormal absorption augment the perversion of the cellular mutations between the elements of the blood by the superior intensity of an increased quantity?

The sensation of *thirst* is urgent and agonizing. Will the drinking of copious portion of cold water allay it? The experience of every physician answers that it will not; but, on the contrary, it will do a positive injury so soon as the quantity is sufficient to distend the stomach, and, by the mechanical force of its pressure on the mucous coat, accelerate its absorption, unless it be happily ejected by vomiting, when the sufferer will feel joyously relieved. A few moments' sweet repose will follow, when the sensation of thirst will return, if possible, more agonizing than before. If copious draughts of cold water afford no relief, if it often be a positive injury, what must be done? Do what pathology imperiously demands.

Neutralize, by molecular combination, the imperfectly combined oxygen of the atmosphere in the blood by the proper use of water. How can this be done? Appease the urgent thirst by the use of ice, broken into small pieces and swallowed; and, when ice cannot be obtained, by small quantities of cold water. Ice is more efficacious than water; it is much more slowly absorbed, and seldom or never does injury by distension. Its hydrogen is at first feebly attracted by the imperfectly combined oxygen in the blood; only a small portion is combined and forms a component part of the water of the blood, while its oxygen has a feeble affinity for the carbon of the blood, in consequence of the imperfect elementary arrangement of the molecular combination of the carbon. As but a small quantity of the water of the ice is absorbed and decomposed, its hydrogen neutralizes by combination an equally limited amount of the imperfectly combined oxygen in the blood; and as this oxygen is introduced in ample quantities at each inspiration, it follows that its consumption should be commensurate with the quantity introduced. Hence the necessity for the employment of water externally. The skin presents a surface of about fifteen square feet, and is liberally endowed with absorbent and secretory glands. These have the same tissual endowments as the same kinds of glands in the abdominal and thoracic organs, and associated in intimate structural arrangement are sensitive and excito-motory nervous branches. As pile upon pile increases the intensity of the electric current, so endowment upon endowment augments the resistance of any particular class of tissues to the force of a disturbing cause.

The mode in which water should be employed when the design is to remove imperfectly combined oxygen from the blood, is plainly indicated by the anatomy and physiology of the skin. The cuticle is of firm structure, and in a greater or less degree covered by an unctuous secretion, which resists the introduction of water by absorption; and, although it is penetrated by a vast multitude of openings or pores, yet these are oblique, and often filled by the unctuous secretion, commingled with other secretions and dust so as to resist the admission of water.

Physiology teaches that cells are the agents the automatic nervous force employs to produce molecular changes in the blood; that they generate and develop, control and distribute animal heat and electricity; that a tissue is a good or a bad conductor of these forms of matter according to the facility and rapidity with which this force can produce molecular changes; and that the capacity of every tissue for the generation, development, and distribution of animal heat and electricity always bears a relation of equivalence to the quantity and the degree of rapidity which the cellular changes of its nutritive materials may transpire. Hence the fluids and the soft solids produce more of these forms of force or matter, and are better conductors of them than the skin.

When it is designed to relieve the blood in the external capillaries from aggregated heat and electricity, and imperfectly combined oxygen, it is there-

fore necessary that the molecular changes should be augmented among the elements of the blood, and that a conducting medium should be applied and retained upon the skin for some time, that the requisite molecular mutations may be produced in the cutaneous capillaries, and that the product of these changes may be conveyed to the surface of the skin. Water is the best medium for this purpose, because the imperfectly combined oxygen in the blood has a strong affinity for its hydrogen, while its oxygen has an equally strong affinity for the carbon of the blood. These reciprocal affinities accelerate the molecular changes of the elements of the blood, and thereby promote the absorption and molecular combination of the water.

These molecular changes elaborate and arrange a portion of animal heat and electricity, imperfectly combined oxygen, and some of the other effete elements of the blood into the form of the secretory compounds of the skin, and cause their removal to the surface, upon which the animal heat and electricity are transmuted into mechanical force, by which sweat or any other fluid is thrown off from the skin in the form of vapour. Authors teach that animal heat is absorbed by the sweat or other fluids on the skin, and becomes *latent*. This is a fallacy. There is no such thing as *latent heat*. If a new form of force is not developed when animal heat and electricity are conveyed to the surface of the skin, what causes sweat, or any other fluid, to assume the form of vapour? Nothing but mechanical force can, in this manner, change the form of water. If this force be not developed by the conversion of heat and electricity into mechanical force, how is it obtained? For a more extended consideration of this interesting subject, read an article I contributed in the July number for 1855 of the *American Journal of Medical Sciences*, in which I maintain the *unity and mutual convertibility* of all the different forms of force or matter.

When it is designed to promote either the secretion of animal heat and electricity from the external capillaries, or when it is desired to communicate them to the different forms of the automatic nervous force in these vessels, water is, therefore, the best medium; and it should be applied and retained upon the skin for some time, because of the anatomical structure and physiological functions which transpire in the cutaneous capillaries. This can be done by means of folded sheets of domestic or linen, neatly and closely rolled around the person, wet in warm or cold water according to the indications to be fulfilled. Dry sheets should be carefully passed around the wet ones for the purpose of keeping the bedding dry. The atmospheric oxygen should be carefully excluded; for when this has free access to the skin, it disturbs and often prevents the reciprocal affinities of the different elements for each other, and thereby arrests or retards molecular changes among the elements of the blood. This is also the most favourable mode of applying water to the skin to promote its absorption; for it is retained upon the skin, and a slight degree of pressure always favours absorption.

When pulmonary or portal congestion exists, especially when unattended

by inflammation, the domestic or linen should be carefully enveloped by a woollen blanket, which is a very imperfect conductor. This would, in a great degree, exclude the oxygen of the atmosphere, retain the heat secreted from the external capillaries, resist its conversion into mechanical force, support the different forms of the automatic nervous force, favour the intensity of the molecular changes of the blood, and thereby promote the secretion of an augmented quantity of its effete elements by the depuratory glands of the skin.

The *local use* of water often contributes greatly to the comfort of the patient, and assists essentially in the fulfilment of important indications of cure by consuming the imperfectly combined oxygen, by which the sensitive nervous branches are soothed; the excito-motory, tranquillized; and the automatic, invigorated. During fever, especially when the skin is hot and dry, three or four folds of linen, wet in cold water and laid upon the forehead, often confers a boon of relief from agonizing pain and burning heat, and thereby contributes essentially to restoring the diseased transformation of the tissues to a normal state by eliciting the compensatory assistance of the sensitive and excito-motory nervous systems. Relieved of the excess of the imperfectly combined oxygen locally manifested by the sensation of pain and burning heat in the external capillaries of the head, these nervous systems impart increased intensity to the different forms of the automatic, augment and accelerate the molecular changes of the blood, and promote the secretion of additional quantities of the effete elements of the blood by the depuratory glands. Congestion of the brain is often only *simulative*, not *actual*. This state of the brain is often observed; and I apprehend it is frequently mistaken in our *Western* alluvion districts, in which individuals are exposed to all the atmospheric vicissitudes incident to a climate, whose physical geography is chiefly composed of rich alluvial soil, clothed in forest trees and vegetation luxuriating in gorgeously exuberant foliage, variegated by winding and often sluggish streams, stagnant bayous, and deep, silent lagoons, which, in the summer and a part of the autumn, are exposed to a high temperature during the day and a low temperature during the night, causing the atmosphere to be more or less loaded with *warm moisture* during the former period, and a *cool, dense vapour* during the latter.

The alluvion districts are irregularly girdled by undulating highlands of clay soil underlaid by limestone. During August and September, these highlands are often dry and parched; the atmosphere is hot and *dusty*; vegetation languishes; foliage fades; the earth glows; the horizon gleams; forest and fields seem a desolate waste. Pass upon the alluvion lands; mark the contrast. The atmosphere is soft and moist; vegetation smiles in exuberance; foliage is robed in deep green attire; forest and fields seem to revel in gay festivity. Evening approaches; darkness mantles the sky; a cool, dense mist-vapour pervades the atmosphere. This physical condition of the atmosphere disturbs the normal relation between the different forms of the automatic nervous force; lesion of nutrition and secretion is produced; lesion of

capillary circulation follows; diseased transformation of all the tissues supervenes; the blood is not normally introduced into the external capillaries from the arterial branches by the molecular changes of nutritive attraction; it aggregates in the portal venous system, in which the varied forms of the transmuted automatic nervous force prevail over the molecular changes of the blood, produce diseased transformations of its elements, and cause their rearrangement, coalescence, and chemical composition in accordance with the laws of chemical combination.

Every attribute of the brain and spinal marrow are created perpetuate, and impaired or destroyed by the molecular changes of the blood produced by the different forms of the automatic nervous force. Hence the functions they perform in the human organism always sustain an intimate relation of dependence on the state of this force in its varied forms. When portal congestion exists, and the different forms of the automatic nervous force are largely transmuted into those of chemical, the molecular changes of the blood in the arterial, venous, and capillary systems are imperfect. These vascular systems in the brain and spinal marrow constitute no exception. The molecular changes of the blood in them partake of the imperfection. Hence the attributes of the brain manifest every degree of lesion from greatly augmented and perverted sensibility to its complete suspension. As the molecular changes of the blood become more and more diseased, the attributes of the brain are more and more perverted, until sensibility becomes very obtuse or entirely suspended.

This condition has often been mistaken for that of congestion. Why? Because of the stupor and insensibility? These are symptoms usually present in both conditions of the cerebral vascular systems. A careful investigation of all the symptoms, and a proper appreciation of the pathological conditions which produce them, will reveal the diagnostic symptoms which indicate the existence of congestion of the brain, and those which evince that of an extreme perversion of the elements of the blood in the cerebral tissues. It is of the first importance to ascertain conclusively, which of these conditions is present; because some of the most potent agents in the treatment of the one would be positively injurious in that of the other. How essential that the diagnosis should be correct. Life depends upon it. The danger of the patient is imminent. The most active means must be employed. Three or four folds of linen or domestic wet in warm water should be applied over the whole length of the spine. The legs and arms should also be enveloped in the same. The linen or domestic should be frequently wet, that its temperature may always remain as high as the patient can endure. Copious injections of warm water should also be given every hour or two, and calomel and opium administered every two or three hours. The necessity for continuing the use of water, as it is here directed for a considerable period, is manifest, when we contemplate the cause of this pathological condition, the

mode in which it was produced, and the means by which the different forms of the automatic nervous force may be restored to a normal condition.

In the April No. of this Journal for 1856, I have discussed the causes of fever at considerable length; and in this paper I have endeavoured to explain the mode in which these causes influence the human organism; what curative indications may be fulfilled by the general use of water applied upon the skin; the futility of drinking copious draughts of water to promote the secretory depuration of the blood; but the vast importance of the subject will require a further consideration of its curative agency, when locally employed.

Pathology teaches that the sensitive and excito-motory nervous systems often lend a compensatory aid to the automatic; and that without them the latter could not maintain all the attributes of the human organism; for although the automatic elaborates and appropriates the material to sustain and perpetuate these; yet it must employ one of them as an agent to bring it into relation with the external world, and the other for the production of muscular motion. The automatic supplies the *creative*, *sensitive*, and *motive* power; the sensitive and excito-motory are endowments which it employs for the manifestation of the higher and nobler attributes of intellectual beings. Hence all these nervous systems maintain a relation of mutual dependence on each other. They all perform functions indispensable to the conservation of the human organism. The imperative necessity for eliciting the reciprocal aid of these nervous systems in simulative congestion of the brain is, therefore, obviously manifest. How can this be best accomplished?

The automatic nervous system is endowed with the creative and distinctive agencies of the organism. These are no longer equal to each other; the destructive predominates. How can this predominance be subverted? The molecular changes of the blood are not normal. The blood is becoming more and more contaminated by effete elements. Normal nutritive elements cannot be introduced. Those which exist must be depurated. The depurative glands of the skin and lungs have sensitive and excito-motory nervous branches in intimate relation with them, while those of the liver and kidneys are without those efficient endowments which always give increased intensity to the different forms of the automatic nervous force. This combination of nervous endowments, which are ever ready to compensate for the deficient functions of each other, bestows upon the tissues to which they are distributed a much more durable resistance to the force of a disturbing cause than that possessed by those which are endowed with automatic nervous branches only.

The anatomical relation which the pulmonary and cutaneous vascular systems sustain to the portal venous system, always causes them to contain less than a normal quantity of blood, where, from any cause, an accumulation of blood takes place in this venous system. The blood in the cutaneous blood-vessels is nearer maturity than that in the internal organs; for, in these it is in every state, from incipiency to maturity; while, in the former, the mass

approaches maturity; and, as a consequence of this, the different forms of the automatic nervous force in the external bloodvessels offers greater resistance to the force of a disturbing cause. From the superior nervous endowments of the external tissues; from the anatomical relation of the external bloodvessels to those in the internal organs, and from the diminished quantity and approaching maturity of the blood in them, the external tissues do not generally suffer as much by a disturbance of the different forms of the automatic nervous force as those of the internal organs. The state of the blood in the external bloodvessels; the intimate relation of the cutaneous depurative glands with sensitive and excito-motory nervous branches; the compensatory relation of functions between the different nervous systems; and the immense expanse of the skin, conspire to make this the most fertile and productive field in which remedial agents can be employed.

Why has it been so much neglected? Because remedial means have not been so used as to elicit the curative agencies of the component tissues of the skin.

Bathing was employed in the earliest ages of antiquity, and it has ever continued to be held in high estimation among many nations. But the proper employment of water as a remedial agent has not sufficiently engaged the attention of the medical profession. Bathing is conducive to cleanliness, and elicits, in some degree, the compensatory aid of the sensitive and excito-motory nervous functions. But the depuration of the blood, when there is any considerable disturbance of the different forms of the automatic nervous force among its elements, requires the continued application of water for a certain period, so as to influence the molecular changes of its elements, promote their formation, accelerate their rearrangement, augment their coalescence, and favour their separation into nutritive and effete elements.

This evinces the necessity for the continued application of water along the course of the spine, when the design is to elicit the compensatory aid of the sensitive and excito-motory nervous branches in the depuration of the blood, when there is extreme perversions of its elements. For the skin over the spine is largely endowed with these nervous branches in a comparatively favourable condition to lend their assistance; the external tissues are more liberally endowed with means of resistance to the force of a disturbing cause than the internal organs; the blood in them, although diminished in quantity, is nearer maturity than in these organs; the different forms of the automatic nervous force in the external tissues, therefore, soon manifest increased intensity when water is applied and retained upon the skin.

The molecular changes of the blood in the minute capillaries about the origin of the excito-motory nerves, and that of the sensitive nerves which arise from the medulla oblongata, are increased in intensity, augmented in quantity, and altered in quality; the elements of the blood are formed and transformed, coalesced and rearranged with multiplied celerity; the nervous roots and adjacent tissues are supplied with additional quantities of nutritive

material; more powerful reflexed actions are transmitted; the compensatory aid of these nervous systems begins to be manifested. Now apply a folded napkin, wet in hot water, over the epigastric region; inspiration is freer; an increased quantity of oxygen is absorbed, and an additional quantity of carbon is secreted by the augmented molecular changes of the blood in the pulmonic capillaries. The mechanical force of the muscular action of the heart and arteries soon receives increased power from the altered quality of blood conveyed to their muscular tissue by their nutritive arteries, and an augmented quantity of blood is propelled and conducted to the external capillaries, in which the different forms of the automatic nervous force have received increased intensity by reflexed action. This intensity may be greatly augmented, and the reflexed action made much more conducive to its integrity by enveloping the arms and legs in three or four double of linen or domestic, wet in hot water, and retained for at least half an hour; because the imperfectly combined oxygen of the atmosphere, conducted along with the blood into the external capillaries, would then attract the hydrogen of the water, combine with it, and constitute water, which would be removed and deposited on the skin in the form of sweat; while the carbon of the blood would combine with the oxygen of the water, evolve heat, and be removed in the form of carbonic acid gas. Freed of the consuming force of the imperfectly combined oxygen, the sensation of pain and burning would not be experienced; the compensatory force of reflexed action would be more manifest, because it would be consumed chiefly by imparting increased intensity to that of the different forms of the automatic, and not by the manifestation of perverted sensation and involuntary muscular motions. It would, therefore, contribute to the molecular changes of the blood, and accelerate its depuration in the external capillaries by favouring absorption and promoting secretion. When we review the immense extent of the skin, when we contemplate the magnitude and wisdom of its endowments, we can appreciate the advantages of its agency in the restoration of the organism, when the varied forms of the automatic nervous force are disturbed and ready to invite the oxygen of the atmosphere into the citadel of life. The arms and legs may be constituted into four fields for the subjection of the rebellious elements of the blood; the commanding officer must be selected and nurtured in the cerebro-spinal region; while new recruits must be trained and mustered into the service of the organism along the course of the alimentary canal.

Copious injections of water should never be omitted in the treatment of fever, as it prevails in the southwest; because there is always more or less biliary derangement; and there is no more efficacious means for the removal of bile and other perverted secretions from the alimentary canal. When the functions of the stomach are so perverted that it will not retain medicine, copious injections of water often have a very salutary effect by removing the altered secretions and other fecal matter from the bowels, by which they promote the tranquillization of the disturbed reflexed actions of the sensitive

and excito-motory nervous systems. This state of the stomach often constitutes a most troublesome complication in the treatment of fever. It is frequently observed in persons who suffer of fever during the hot days of August and September. Copious injections of warm water should be frequently employed; a towel, wet in cold water, should be folded and laid over the entire epigastric region; three or four folds of domestic or linen about six inches in width, wet in cold water, should also be applied over the whole length of the spine and retained for an hour or two; a folded napkin, wet in cold water, may often be advantageously applied over the larynx, especially when the vomiting is persistent. The application of water, in this manner, is of peculiar advantage in controlling the persistent vomiting of children during the period of dentition, because of its efficacious influence in tranquillizing the reflexed actions which the evolution of teeth so greatly augments. Both the colligative diarrhoea and the persistent vomiting which so frequently afflict children during this tender period are chiefly dependent upon, and often are perpetuated by, this perverted nervous action.

Unless the individual is of intemperate habits the use of water, as here directed, seldom fails to tranquillize the stomach, remove the perverted secretions from the bowels, and prepare the organism for the favourable reception of other remedial agents.

Dr. Henry F. Campbell, of Augusta, Ga., has published two very able and interesting essays on the pathology of reflexed nervous actions during dentition and during fever, with certain complications. These are invaluable contributions to medical science, and they will serve as beacon lights to every pathologist (*South. Med. Journ.*, for June, 1850, and *Trans. Amer. Med. Ass.*, for 1853.)

After the bowels are freely moved and the stomach nearly tranquillized, great advantage may often be derived by enveloping the patient in sheets wet in cold water. Dry sheets should be rolled neatly around the wet ones, and the whole allowed to remain until the sensation of heat and pain is removed. From half an hour to an hour will generally be sufficient to produce this effect. The prompt and judicious administration of quinine will generally prevent the recurrence of these symptoms. During the forming state of fever, and often during the first day or two of its progress, obstinate constipation is frequently observed. For the removal of this complication large injections of warm water are peculiarly efficacious, because they neither offend the stomach nor delay the administration of other appropriate agents. They promote the dejection of the accumulated fecal mass and depraved secretions, and contribute to the normal restoration of the perverted nervous functions.

Diarrhoea is a very troublesome complication of fever, because it greatly promotes the debility consequent upon the fever, causes nutritive material to be voided before it is assimilated, and renders remedial agents much less efficacious. It is often present during the progress of a fever; but it is much more frequently observed during the protracted continuance of a fever as it prevails

in our alluvion river bottoms, with a vast multiplicity of complications. No remedial agent is more efficacious in the removal of the cause of this diarrhoea than large injections of cold water. These should generally be employed twice or three times a day; but they may often be advantageously used after each evacuation of the bowels. The long continued recession of the blood from the external capillaries and its persistent lodgement in the portal venous system, contribute to the perversion of the functions of the vast multitude of absorbent and secretory glands along the course of the alimentary canal, because of its accumulated quantity and altered quality in the intestinal capillaries; while the augmented amount and perverted quality of the biliary secretion is conveyed to the organizing force of many of these glands; but this force is so diminished in intensity by the altered quality of the blood in these glandular capillaries, that when the perverted biliary secretion approaches the glands its nascent formative condition is transmuted, and the constituents of the food, which it was forming into elements of blood, are attracted, combined, and dejected with this altered and perverted fecal compound. This constitutes what is commonly called *irritation* of the mucous membrane of the bowels.

When we see the vast number of absorbent and secretory glands in the mucous membrane of the alimentary canal; when we contemplate the important and multiplied functions they perform for the conservation of the organism, we can easily appreciate the immense advantages of their constant and careful protection, and of their earliest possible relief when disturbed in functional duty.

In the treatment of this complication of fever I greatly prefer cold water injections to all the much commended astringents, because they seldom favour the production of other and often more dangerous complications, as some astringents frequently do; and they promote the establishment of a state of the organism favourable to the administration of quinine and other necessary remedial agents.

Bathing is often a valuable therapeutic agent to harmonize the relation between the nervous systems when no considerable degree of diseased transformation of the tissues exists. It may, therefore, be often advantageously employed in the forming state of fever, or during the convalescence of a patient.



